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Reexamination of an Anomalous Distribution: Resurrection of *Ramphotyphlops becki* (Serpentes: Typhlopidae)[1]

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ABSTRACT: *Ramphotyphlops becki* (Tanner, 1948), restricted to Guadalcanal, Solomon Islands, is resurrected from the synonymy of *Ramphotyphlops willeyi* (Boulenger, 1900), from the Loyalty Islands, on the basis of consistent differences in external morphology and visceral anatomy. New records of *Ramphotyphlops braminus* (Daudin, 1803) are reported from Vanuatu and the Loyalty Islands.

THE TYPHLOPID SNAKES of the Solomon Islands were revised by McDowell (1974), who recognized six species from the archipelago, all placed in a single genus (then *Typhlina,* now *Ramphotyphlops* [ICZN 1982]): *R. affinis* (Boulenger, 1889), *R. angusticeps* (Peters, 1877), *R. braminus* (Daudin, 1803), *R. flaviventer* (Peters, 1864), *R. suboccularis* (Waite, 1897), and *R. willeyi* (Boulenger, 1900). McDowell's (1974) revision was valuable for its introduction of new characters into typhlopid systematics and for the thorough literature review, but it suffered from the small samples available for many species. The largest sample from the archipelago was for *R. flaviventer* (5); for two species, *R. braminus* and *R. suboccularis,* the only examined specimens were extralimital to the Solomons. This paucity of material resulted in a conservative bias to "... regard related forms as conspecific unless some compelling evidence indicates their distinctness...." (McDowell 1974: 3). Recent revisions of two of the Solomons typhlopids using larger samples revealed that this bias seriously underestimated typhlopid species diversity in the New Guinea–Solomons region (Wallach 1995, 1996), with McDowell's species being composite. In this paper we consider the identity of a third Solomon Islands typhlopid, identified by McDowell as *Typhlina willeyi.*

Typhlops willeyi was described by Boulenger (1900) from a single specimen (Natural History Museum, London 1900.5.29.1, now 1946.1.10.80) from Lifu (= Lifou) in the Loyalty Islands near New Caledonia. Two additional specimens of this species have been reported from the Loyalty Islands: Naturhistorisches Museum Basel (NHMB) 7088 (Roux 1913) and American Museum of Natural History (AMNH) 62687 (McDowell 1974), both from Maré. We are unaware of any additional material from the Loyalties (see also Sadlier and Bauer 1997).

Almost half a century later, *Typhlops becki* was described by Tanner (1948) from a single specimen (Brigham Young University [BYU] 7448) from near the 20th Station Hospital on the Tenaru River, Guadalcanal. Tanner (1951) provided an abbreviated redescription.

Despite noting several differences between *T. willeyi* in the Loyalties (as represented by AMNH 62687 and the descriptions of Boulenger [1900] and Roux [1913]) and the Guadalcanal taxon (as represented by the holotype), McDowell (1974: 48) synonymized the two, noting "these differences do not seem any greater than might be expected as a result of geographic variation within a single species, and if two species are involved, each is the other's closest relative." He also noted that AMNH 62687 was more slender than the other two Loyalty Islands specimens, whereas the holotype of *T. becki* was in better agreement with Boulenger's (1900) description in this respect.

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This synonymy created the unusual distribution pattern of a single species naturally distributed on two distant island chains, but not on intervening islands, including more eastern parts of the Solomon Islands archipelago or Vanuatu. The possibility that this is merely an artifact of collecting effort is unlikely, with typhlopid collections known from Vanuatu (the parthenogenetic human commensal *R. braminus* [Medway and Marshall 1975]; Australian Museum [AM] R58921 Vila, Efate; R116271, R118066, Luganville, Espiritu Santo; R118063–65, Tagabe Agricultural Station, Efate; 118090, Mele, Efate; R132891, 5 km N Vila, Efate; R132939, base of Paonapokas Bernier Mtn, 9 km N Vila, Efate) and the more eastern Solomon Islands, including Malaita, Three Sisters I., Rennell I., and San Cristobal (*Acutotyphlops infralabialis* (Waite, 1918), *R. affinis, R. angusticeps,* and *R. depressus* (Peters, 1880) [McDowell 1974, McCoy 1980, Wallach 1995, 1996]). McDowell's synonymy has been accepted with reservation by subsequent authors (McCoy 1980, Bauer and Vindum 1990, Allison 1996, Sadlier and Bauer 1997).

We have had the opportunity to examine the two specimens from the Loyalties not examined by McDowell and 13 additional specimens from the Solomon Islands, all from Guadalcanal: AM R40836; Queensland Museum (QM) J4420, no additional locality data; R71358, R77119, Mt. Austen; Museum of Comparative Zoology, Harvard (MCZ) 110248, 110250–53, 110257, 110259, Mataruka; 110256, Mt. Austen, 8000 ft [2400 m]; 110258, Malukuna, 2500 ft [750 m]. These specimens, together with the descriptions of AMNH 62687 and BYU 7448 by McDowell (1974), indicate that the two geographically distinct populations are consistently different in several external features and have a number of differences in visceral anatomy.

Guadalcanal specimens have 20 scales at midbody; a range of 209–241 (mean = 226.2, SD = 8.88, $n = 14$) dorsal scales (males 209–229, mean = 219.2, SD = 6.46, $n = 6$; females 224–241, mean = 232.0, SD = 6.83, $n = 7$); a range of 8–15 (mean = 10.8, SD = 2.34, $n = 13$) subcaudal scales (males 11–15, mean = 13.2, SD = 1.79, $n = 5$; females 8–11, mean = 9.3, SD = 1.11, $n = 7$); a rounded snout in dorsal view; rostral parallel-sided; snout-vent length 62–148.5 mm (males 75–128 mm, $n = 6$; females 120–148.5 mm, $n = 7$, four of which are larger than the largest male); tail length/snout-vent length ratio 2.4–5.4% (mean = 3.7%, SD = 0.93, $n = 14$; males 3.8–5.4%, mean = 4.5, SD = 0.70, $n = 6$; females 2.4–4.0%, mean = 3.1, SD = 0.59, $n = 7$), and body width/snout-vent length ratio 3.2–5.9% (mean = 4.4%, SD = 0.71, $n = 13$). In coloration, most specimens have the dorsum reddish brown to dark purplish brown, the venter paler brown, and variably expressed white to yellow patches associated with the supralabials, chin, and vent. Two females (QM J4420, snout-vent length 125 mm, no date of collection; MCZ 110258, snout-vent length 139 mm, collected 2 July 1968) have single large oviductal eggs.

In contrast, the three specimens from the Loyalty Islands have 22 midbody scales; 369–375 dorsal scales (male 372, females 369, 375); 14–15 subcaudal scales ($n = 2$; female, male respectively); a pointed snout in dorsal view; rostral with a medial constriction (hourglass shaped) in NHMB 7088; snout-vent length 166–184 mm for the two females, 190 mm for the male; tail length/snout-vent length ratio 2.2–2.6% ($n = 2$; female, male respectively); and body width/snout-vent length ratio 1.8–2.7% (mean = 2.3%, SD = 0.45, $n = 3$). In coloration, the two specimens we have examined are mid-brown dorsally and paler brown ventrally, either lacking pale patches (holotype) or with yellowish patches around the lips, chin, and vent (NHMB 7088).

V.W. has examined the viscera of three specimens from Guadalcanal: MCZ 110252, 110256 (males), and 110258 (female), and the single male Loyalty Islands specimen (NHMB 7088).

Although the sample size is very small, the majority of visceral characters revealed nonoverlapping values between the two taxa. The data presented below (grouped by measurement category: midpoint, length, gap, interval, etc.) are for the Loyalty Islands individual versus the mean (range) for the

Gaudalcanal sample; unless indicated otherwise, all values are percentage snout-vent length with ratios of four visceral characters presented as two-place decimals. "Total" refers to right plus left organs. "Gap" refers to the separation between two structures, and "interval" measures the two structures together with the separation between them.

Midpoints: trachea, 19.2 versus 21.6 (20.5–22.2); trachea-bronchus, 25.3 versus 27.0 (25.5–27.9); tracheal lung, 23.9 versus 27.2 (26.3–28.1); heart, 34.6 versus 38.4 (36.7–39.3); right lung, 44.2 versus 48.1 (44.6–50.5); gall bladder, 70.7 versus 67.4 (65.8–69.1); right gonad, 82.1 versus 76.7 (72.7–80.7); left gonad, 84.7 versus 80.6 (78.2–83.6); total gonad, 83.4 versus 78.7 (75.5–82.2); right testis, 82.1 versus 78.8 (76.8–80.7); left testis, 84.7 versus 81.9 (80.1–83.6); total testis, 83.4 versus 80.3 (78.5–82.2); right adrenal, 83.7 versus 78.7 (76.8–81.2); left adrenal, 86.1 versus 82.6 (81.5–84.5); total adrenal, 84.9 versus 80.7 (79.3–82.9); left kidney, 92.9 versus 90.2 (88.2–92.4). Other points: anterior tip of tracheal lung, 11.1 versus 13.3 (12.6–14.3); posterior tip of right bronchus, 49.0 versus 52.0 (49.6–53.6).

Length: sternohyoideus muscle, 12.6 versus 17.8 (15.1–19.6); trachea, 35.3 versus 39.1 (38.1–39.7); bronchus, 12.1 versus 10.8 (10.1–11.6); trachea-bronchus, 47.4 versus 49.9 (48.2–51.3); heart, 4.5 versus 5.7 (5.4–5.8); right liver lobe, 25.5 versus 20.2 (19.3–21.6); left liver lobe, 26.1 versus 20.6 (20.3–20.9); total liver, 51.6 versus 40.7 (39.6–42.5); right testis, 1.6 versus 3.3 (2.9–3.6); left testis, 1.6 versus 3.5 (3.1–3.9); total testis, 3.2 versus 6.8 (6.7–6.8); right kidney, 3.7 versus 5.3 (4.9–5.8); left kidney, 4.2 versus 4.9 (4.8–5.0); total kidney, 7.9 versus 10.2 (9.8–10.8). Gaps: heart-liver, 0.5 versus −1.3 (−0.4 to −2.2); heart–gall bladder, 32.9 versus 25.1 (24.1–26.1); gall bladder–gonad, 9.7 versus 5.8 (1.4–9.2); right adrenal–kidney, 2.6 versus 5.2 (3.1–9.0). Intervals: snout-heart, 36.8 versus 41.2 (39.6–42.0); heart-liver, 33.2 versus 26.9 (26.1–27.3); liver–gall bladder, 31.6 versus 26.2 (24.1–27.3); kidney-vent, 13.2 versus 15.5 (13.7–17.9).

Ratios: sternohyoideus (posterior tip)/snout-heart gap, 0.39 versus 0.50 (0.45–0.54); right and left systematic arch junction gap/heart length, 0.29 versus 0.22 (0.17–0.25); left and right liver midpoint gap/liver length, 0.04 versus 0.09 (0.08–0.09); kidney overlap/total kidney length, −0.03 versus 0.27 (0.16–0.40). Meristic: estimated tracheal rings, 234 versus 163.5 (143–180); estimated tracheal rings/10% SVL, 68.4 versus 41.1 (35.5–46.3); tracheal lung air chambers and niches, 21 versus 13.3 (11–15); number of coils in retracted hemipenis, 6 versus 3.5 (2–5); liver lobes 7/5 versus 2/2.

The tracheal lung is distinctly different in the two populations: the Guadalcanal population has a paucicameral organ with 11–15 avascular niches, each of which is divided by a vertical septum, whereas the Maré specimen has a multicameral organ with 21 vascularized chambers (see Wallach [1998] for a discussion of lung characters).

Several other characters exhibit mean differences but have marginally overlapping values, such as the total lung midpoint, 31.3 versus 34.1 (31.3–35.7); anterior liver extension/total liver length, 0.09 versus 0.11 (0.09–0.12); posterior liver extension/total liver length 0.07 versus 0.09 (0.07–0.12); liver-kidney interval, 57.6 versus 52.8 (49.1–57.6), total kidney midpoint, 90.8 versus 88.7 (86.4–90.8), and kidney-vent gap, 5.0 versus 7.4 (5.0–9.4).

On the basis of the consistent differences in scalation, size, and coloration, together with the differences observed in visceral anatomy, we have little hesitation in recognizing the two populations as specifically distinct. We reject McDowell's view that the differences are of a level that could be explained as geographic variation within a species. Unlike many other typhlopids, most *Ramphotyphlops* species have very little or no variation in number of midbody scales, and the differences in dorsal scale number and visceral anatomy seen here are of a magnitude much greater than previously reported within a species. The name *Ramphotyphlops becki* applies to the Guadalcanal species, leaving *Ramphotyphlops willeyi* restricted to the Loyalty Islands.

This conclusion removes the anomaly of a

monotypic species occurring in two distant island arcs, but does not exclude the possibility (McDowell 1974) that the two species are sister-taxa. McDowell (1974) considered a composite *R. willeyi* to belong to a species group otherwise only containing *R. subocularis,* diagnosed by the presumed synapomorphies of a wedge-shaped snout and absence of a rectal cecum. Wallach (1995) has since demonstrated that *R. subocularis* is a diagnosable lineage of at least four species, which he accorded generic status as *Acutotyphlops.* He transferred *R. willeyi* to the *R. flaviventer* species group, diagnosed by a unicameral right lung, within which the composite *R. willeyi* had the two uniquely apomorphic states that formerly diagnosed McDowell's *R. subocularis* group. However, Wallach (1996) reported a paucicameral right lung in *R. depressus* and a multicameral right lung in *R. flaviventer,* the two most widespread members of the *R. flaviventer* group. Further, a unicameral right lung is plesiomorphic and hence provides no support for the evolutionary reality of the *R. flaviventer* group.

We confirm that both *R. becki* and *R. willeyi* lack a rectal cecum and, in comparison with the members of the *R. flaviventer* species group, have a more wedge-shaped snout in profile (though only markedly so in *R. willeyi*). Thus there is some evidence for a sister-taxon relationship, with *R. willeyi* the more modified form. However, the relationships of the two species to other *Ramphotyphlops* remain unresolved.

The recognition of the two species as distinct is of significance from a conservation viewpoint, with *R. becki* now restricted to a single (albeit large) island, Guadalcanal, and *R. willeyi* restricted to two small islands with a total area of 1800 km^2 (Sadlier and Bauer 1997). The latter species was most recently collected in 1939 (McDowell 1974), and recent herpetological collecting activity on both Maré and Lifou, including searches for fossorial species, has failed to locate specimens, despite collecting all but one other terrestrial reptile species previously reported from the Loyalties (Sadlier and Bauer 1997). However, two specimens of *R. braminus* (R147350–51; collected P. Grankoff, 19 June 1991) from the plateau of Maré have recently been received at the Australian Museum, confirming tentative previous reports (Bauer and Vindum 1990, Sadlier and Bauer 1997) of a second, presumably recently introduced, typhlopid in the Loyalty Islands.

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